AD-A126 635 CONSOLIDATED DAMAGE CONTROL SYSTEM(U) NAVAL RESEARCH LAB WASHINGTON DC F W WILLIAMS ET AL. 08 APR 83 NRL-MR-5045 1/1

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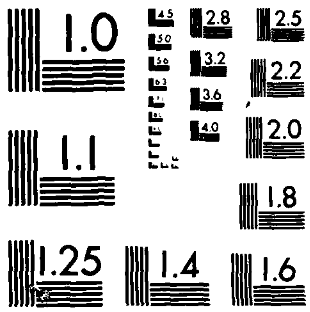


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Shipboard damage control of today, which includes fire prevention, detection and suppression, is much the same as during World War II. Yet, in view of Navy peacetime disasters in the last three decades and the impact of new materials and technology on ships, it is necessary to up-date damage control to be in consonance with the requirements of ships of the 21st century. An advanced damage control concept is presented in this report which takes advantage of logic aided fire detectors, through the hull

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20. ABSTRACT *(Continued)*

communication techniques, minicomputers, fire spread prediction models, smoke movement prediction, instant recall of ships design, ventilation patterns, crew densities and other information pertinent to a ship. This Consolidated Damage Control System concept will not only aid in the survival of a ship through fire prevention, rapid detection, and suppression, but also will significantly enhance the crew's ability to carry out its primary function, namely, to remain on the fighting line. It also has the pronounced added benefit of keeping both the damage control assistant (DCA) and ship's captain informed on a running real-time basis of extent of damage, predicted expansion of damage and progress of control.

CONTENTS

CONSOLIDATED DAMAGE CONTROL SYSTEM

## INTRODUCTION

The Navy's ships are unusually vulnerable to fire because they carry large quantities of fuel and ammunition and have many sources of ignition. Furthermore, their platforms are designed to "go in harms way" in a hostile environment, the sea. In the last three decades, peacetime disasters have been severe. In wartime, fires can be expected to be significantly exacerbated (as shown by the British losses in the Falklands). With few places to run and no fire department down the street, a ship must combat all unwanted fires successfully if it hopes to remain on station to carry out its primary mission - namely, to fight the enemy instead of the fire.

Some of the disasters, other than combat inflicted, have continued to plague the Navy and have received much publicity. Figures 1 -3 show the aftermath of fires on the BELNAP and ENTERPRISE. The SARATOGA, ENTERPRISE, ORISKANY, CONSTELLATION, FORRESTAL, KITTY HAWK, KNOX, ROARK, AND BELKNAP have suffered major fires, the STEINAKER and FRANK KNOX, major groundings, and McMORRIS AND KENNEDY, among others, collisions. Since 1970 the Navy has had over 10,000 reported fires on ships, over 30 of which cost over $100K each and a few over ten million each (1). Since 1952 a total of 383 lives have been lost on aircraft carriers alone due to fires. It must be emphasized that none of these losses were due to enemy action. These fires, groundings and collisions have raised questions as to the modern naval ship's ability to sustain a major catastrope and effectively combat the associated fire, flooding and structural derangement.

Much of the fire loss and damage can be attributed to materials which freely propagate combustion, emitting smoke and highly toxic gases. It is generally estimated that over half of the deaths in fires are due to smoke inhalation alone (2). Manifestly, many lives could be saved and property damage greatly reduced aboard ship if ways could be found to detect and suppress fire and smoke quickly and permit more rapid access to and egress from the fire situations. Further reductions in fire losses could be achieved by controlling the flammability characteristics of shipboard materials and by improved fire suppression techniques and agents. Shipboard damage control is broader than just fire fighting. Damage control consists of the measures necessary to preserve or re-establish watertight integrity, stability, maneuverabilty and offensive power. Thus, it impacts on control of list and trim; effects repairs of materials; limits the spread of and provides protection against the effects of chemical and biological agents or noxious gases

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and radiation; and provides care for wounded personnel. These requirements are set forth in various documents (3).

Essentially shipboard damage control has not kept pace with technological advances in enemy weaponry, ships weaponry, and other ships systems. The increased application of more volatile fuels in boilers, higher yield weaponry and more powerful incendiaries carried represents a severe threat to the ship in event of an accident. The heavy dependence upon them for offensive and defensive capability have produced a situation where relatively minor damage, unless it is rapidly isolated and controlled, can cause critical and major degradation of capabilities.

The present heavy dependence upon men for virtually all functions in operational damage control presupposes that an adequte number of fully trained personnel will be available when needed. An apparent solution is increased automation. A concept to achieve this, the Consolidated Damage Control System, was presented by the authors at a Workshop on Shipboard Fire Protection Research and Development in 1976 (4) sponsored by the Naval Sea Systems Command, the Director of Naval Laboratories and the Naval Research Laboratory.

## CONCEPT

Conceptually the Consolidated Damage Control System would take all practicable preliminary measures to prevent damage. When an "incident" does take place, action could be taken to minimize and localize such damages immediately. The System would allow for emergency repairs, restoration of equipment and care of injured personnel as quickly as possible. These objectives would preserve stability, fume and watertight integrity (buoyancy), while trying to maintain the operational capability of vital systems. They would also be met by preventing, isolating, combating, extinguishing and removing the effects of fire and explosion. Detecting, confining and removing the effects of radiological, biological, or chemical contamination, preventing personnel casualties, and faciliting care of the injured would also meet the objectives of the Consolidated System. Rapid repair to the structure and equipment would also have to be made to return the platform to a combat ready status.

The approach to the System concept proposed here would be accomplished primarily with software with a minimum amount of hardware. Tandemly operating, inexpensive minicomputers with the capability of storing tremendous quantities of information and with high operating reliability are now available. The software would be designed to be interactive. For instance, a stimulus

from a detector, electronic or man-produced alarm, would set the entire damage control program into motion with the following roles being played:

(a) Receive, evaluate and process inputs from all detector systems.

(b) Receive and evaluate information from all damage control/repair parties.

(c) Inform command of conditions affecting the material condition of the ship, including buoyancy, list, trim, stability and watertight integrity.

(d) Initiate orders to repair parties, as necessary, to direct control of damage.

(e) Keep command appraised of progress in combating damage, fire, flooding, the effects of NBC attack, and the extent of significant personnel casualties.

(f) Show best escape routes for personnel trapped below.

(g) Evaluate the necessity of flooding magazines endangered by fire, make recommendations to the Commanding Officer and act upon orders issued.

(h) Initiate orders, as necessary, to control watertight integrity, flooding, counterflooding and dewatering.

(i) Maintain the following material as described

(1) Charts and diagrams suitably labeled to show subdivisions of the ship and its systems.

(2) A casualty display of the damage sustained by the ship and corrective action in progress.

(3) A display of the liquid loading, the location of flooding boundaries, the effect of list and trim caused by flooding compartments and the corrective action taken with regard to stability.

(4) Diagrammatic presentation of access routes for ready shelters, casualty control and battle dressing.

(5) Deck plans to indicate areas contaminated by NBC agents, decontamination stations and safe routes.

(6) A closure log to show the state of closure of the ship.

(7) Fire, flooding and NBC contamination prediction plot.

The liberal use of already developed graphic packages would more rapidly and accurately collect and disseminate information. Such displays could also be used to make decisions based on known options that would be available.

## HARDWARE/SOFTWARE OF CONSOLIDATED DAMAGE CONTROL SYSTEM

The Consolidated Damage Control System can be represented pictorially, see Figure 4. The heart of the System consists of several minicomputers located at different places in the ship (to avoid loss of the system in case of 'lucky' hit). These would essentially be the heart of the Consolidated Damage Control System and could be shifted if the need arose.

The executive program which would be under control in the computer would have many subprograms which would be invoked as the need arose. The programs would be brought into the foreground memory depending on the stimuli, answering the need for fire, flooding, repair, routine trouble shooting of itself and as a training device. The programs would only be limited by our imagination.

Let us consider a program, which would be required to answer a fire threat. Detectors in the affected compartments would signal a threat. Logic aided fire detectors currently under development would be highly reliable as opposed to previous shipboard fire detectors. The stimuli from the detector would be transmitted to the Consolidated Damage Control System by the new concept of communication through the hull. This new technique under development at NRL would eliminate the use of wires and thus allow unlimited communication links. The stimuli would not necessarily have to come from a detector - it could be an alarm raised from an individual or another type of insult such as flooding.

The central processor once it received the message could involve the correct software to deal with the problem.

Numerical models are under development which would predict fire growth, spread, flashover and other pertinent properties of fires. The processor would make use of stored ship drawings

(geometry), ventilation patterns, and environmental conditions to predict fire growth.

Information pertinent to the fire spread, time to take corrective action before fire spread would reach a critical area of the ship, types of damage control to be employed, expected casualties, types of casualties, best routes of escape and best route to attack the fire would be appropriately displayed. Other information, if input to the computer from other ships systems, could be used by the Commanding Officer to assess the fighting capability of his ship.

As more responses were reviewed from various detectors, a continued update of the situation would be calculated by the computer. These trends could be noted and further prognostications could be made.

Obviously, large quantities of information would be available; therefore, graphical displays of information would be imperative. The computer could also aid in decision making by presenting the various options and the probable ramification for these options.

## RECOMMENDATION FOR DEVELOPMENT OF THE CONSOLIDATED DAMAGE CONTROL SYSTEM

There is enough information available today to put together a working damage control system based on the concepts outlined in this report. However, it would not have the degree of sophistication that the authors envision would be possible if R&D efforts were specifically directed toward its development.

Areas that are weak and need further research include: development of a second detector for incorporation into the logic-aided detector, transducer development and interface work for the hull communication, fire scaling, fire model, and information retrieval and processing.

The development of the Consolidated Damage Control System at the hardware level does not need to wait for the basic development as long as the system is structured to be updated as further information becomes available. The concepts as they are developed in the research programs would be incorporated into modules which would be inserted in the computer as updates. This makes the system dynamic and would not need major updating except as newer and more efficient hardwares were developed.

The Consolidated Damage Control System as envisioned by the authors will give the Navy the 21st century damage control

capabilities we should have to complement the other advanced systems on our ships of today and the future.

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## LIST OF FIGURES

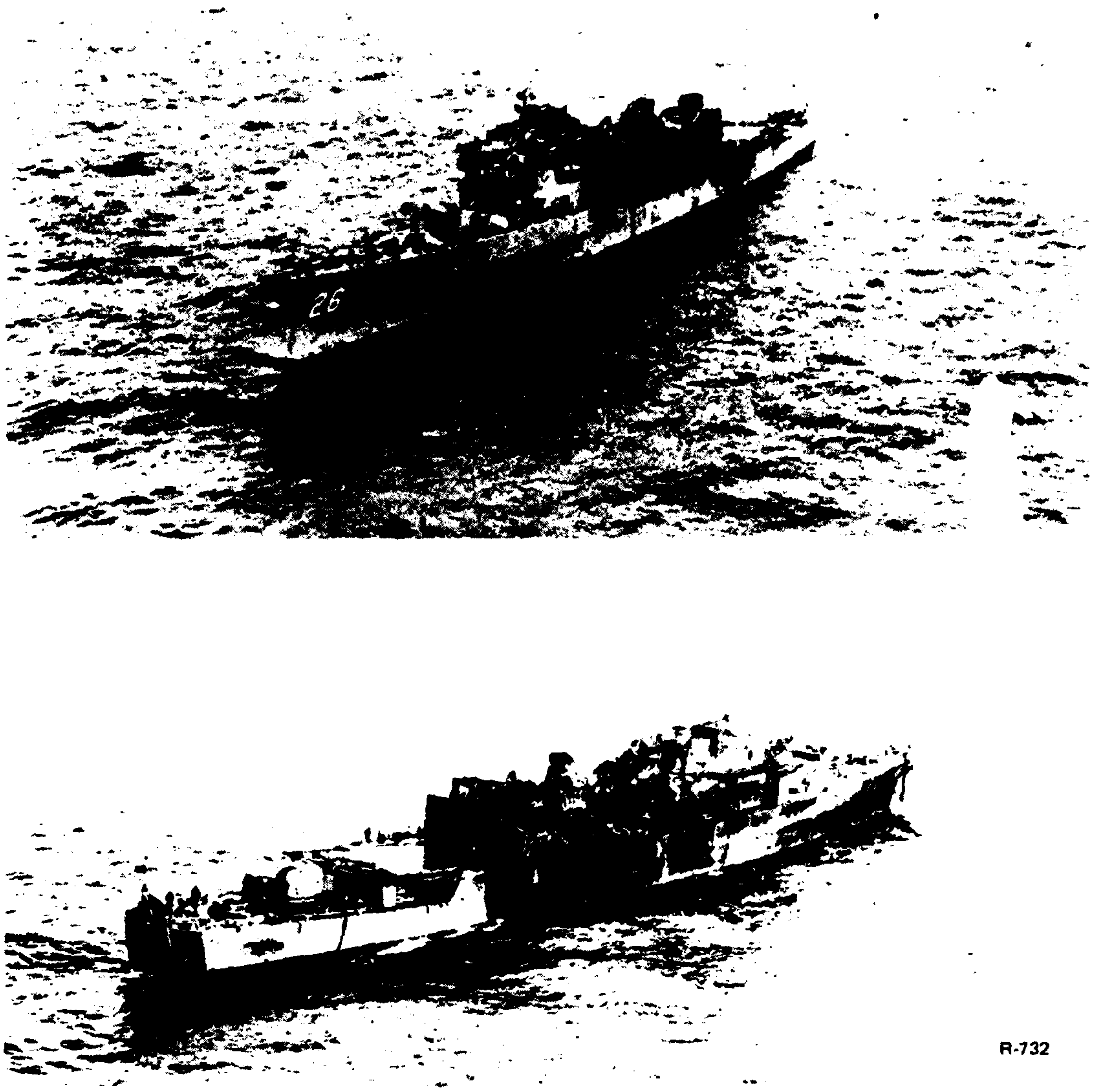


**Fig. 1 — BELKNAP undertow after her collision with USS KENNEDY - note the whole middle super structure was virtually eliminated by fire.**

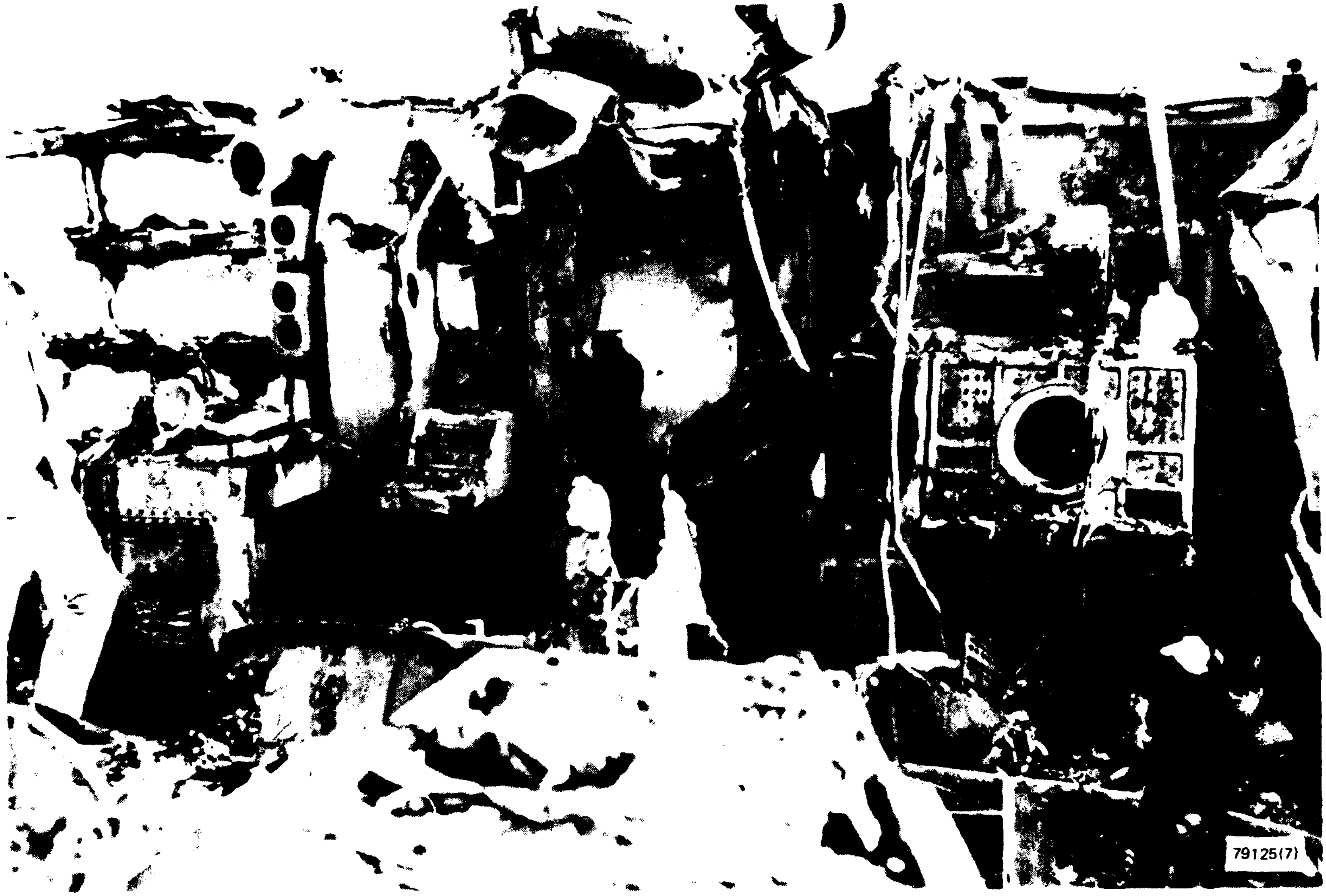


Fig. 2 — Close-up view of a compartment on BELKNAP

Fig. 3 – Deck of Aircraft Carrier ENTERPRISE following an aircraft mishap

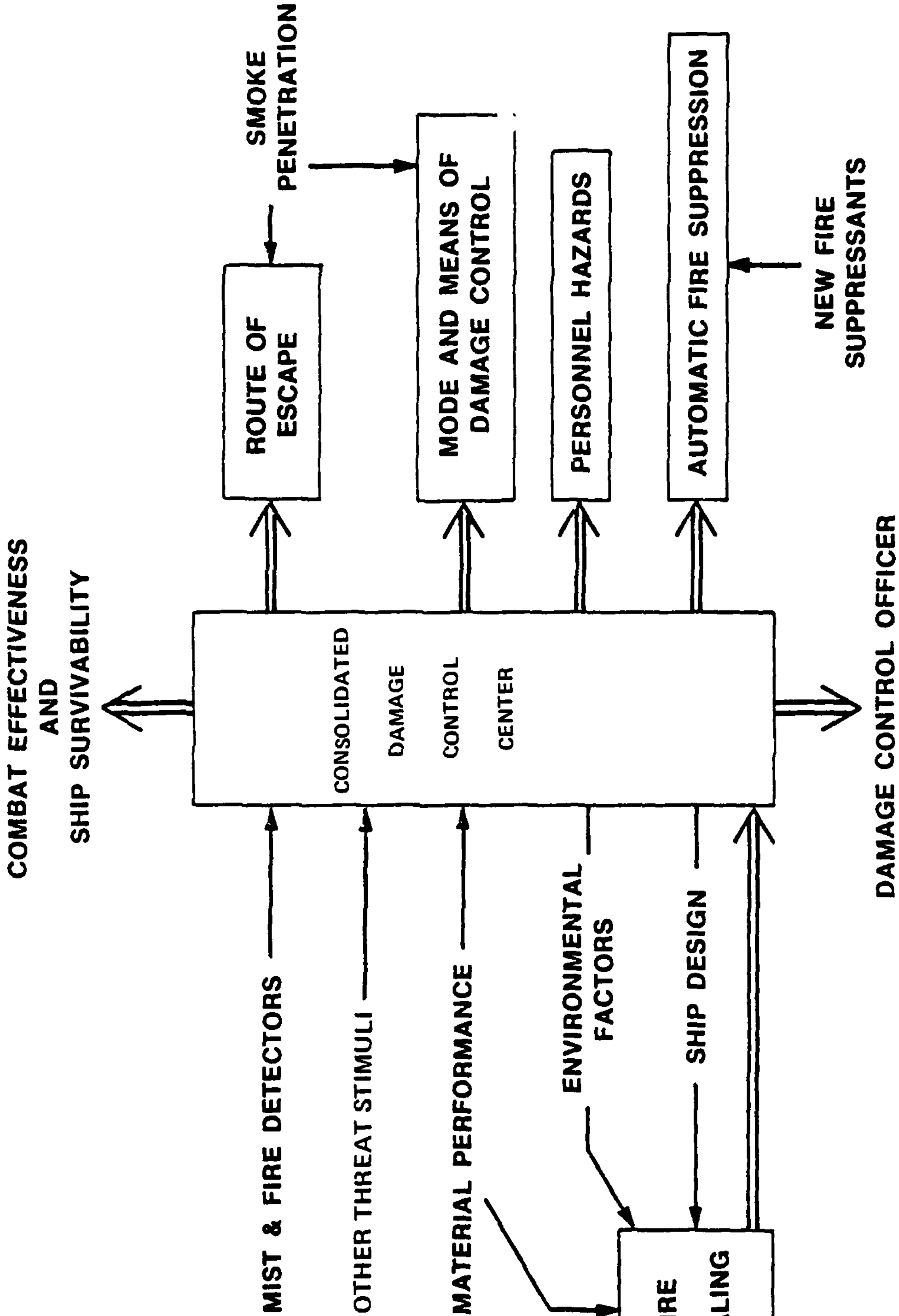


Fig. 4 -- Schematic of Damage Control Central

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